



INSTITUTE FOR DEFENSE ANALYSES

**The Major Causes of Cost  
Growth in Defense Acquisition**  
**Volume I: Executive Summary**

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## I. BACKGROUND

This report identifies the primary causes of major cost growth through case studies of eleven Major Defense Acquisition Programs (MDAPs) and offers recommendations for better controlling cost growth in future programs. It identifies, with the full benefit of hindsight, particular decisions and mistakes that resulted in cost growth, not with the intent of blaming individuals, but to illuminate problems in the Department of Defense (DoD) acquisition process that point the way to the recommendations for improvements. In this context it is important that the reader bear in mind that successful Defense acquisitions depend on the efforts of many participants in the process. The Defense Acquisition Executive (DAE), to be sure, has primary responsibility for the key decisions on the major programs and for the overall functioning of the acquisition system, but the quality and successful implementation of these decisions depend on many others—the supporting staffs in the Office of the Secretary of Defense (OSD), the Joint Staff, the Services, including the Service Acquisition Executives (SAEs), government program managers and contracting officials, and the defense contractors. This large ensemble of participants must work well together as a team to provide the information and analyses to support good decisions and to carry them out once they are made.

Decisions about MDAPs, moreover, touch on the core interests of important powers outside the formal acquisition process both inside and outside DoD, and the DAE must exercise a keen understanding of those forces, including the transcendental goals of the administration of which he is a key member. This report is intended, not to indict the past, but to help future decision-makers avoid the pitfalls it identifies.

Despite the efforts of the Clinton and Bush administrations to control them, the estimated total costs of MDAPs were reported by the Government Accountability Office (GAO) to have increased by about \$300 billion during the 1990s and 2000s.<sup>1</sup> Although this GAO total was considered by many to be an exaggeration, it was also recognized that the Department did, in fact, have a serious problem with cost growth.<sup>2</sup> But cost growth has not been uniform: a

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<sup>1</sup> Testimony before Federal Subcommittee on Federal Financial Management, Michael J. Sullivan, Director, Acquisition and Sourcing Management, *Defense Acquisitions: Fundamental Changes are Needed to Improve Weapon Procurement Outcomes*, Government Accountability Office, GAO-08-1159T, September 25, 2008.

<sup>2</sup> For example, see “Memorandum: Cost Performance on Defense Acquisition Programs,” Under Secretary of Defense (AT&L) John J. Young to Secretary of Defense, March 31, 2009.

disproportionate fraction of the total came from a distinct minority of the programs.<sup>3</sup> Recent analysis<sup>4</sup> demonstrates that most programs continue to exhibit the modest cost growth observed on programs that had passed Milestone (MS) B in the late 1980s to mid 1990s. The main driver of the higher average production cost growth for programs that subsequently passed MS B during 1998-2001 was simply that a greater fraction of programs exhibited exceptionally high cost growth of above 30%.

In 2008, the Director for Acquisition Resources and Analysis in the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (OUSD(AT&L)) commissioned the Institute for Defense Analyses (IDA) to identify the particular causes of major cost growth by developing case histories for a set of particularly troubled programs, and to recommend changes to DoD processes and procedures that would limit such growth in the future.

Working with the sponsor, IDA selected for study eleven important programs that had entered full-scale engineering development between 1995 and 2006 and subsequently experienced cost growth that breached or had come near to breaching the thresholds established by the Nunn-McCurdy Act.<sup>5</sup> The study team assembled histories of the programs by examining official records and through interviews with former senior acquisition officials and their staffs, cost estimators and analysts in the Office of the Director Program Analysis and Evaluation (PA&E—recently renamed Cost Assessment and Program Evaluation (CAPE)), and personnel in the military departments. This report presents the findings of those analyses, together with general conclusions regarding the sources and contributing factors of cost growth and recommendations on how to constrain acquisition cost growth in the future.

The interviews with senior acquisition officials were quite valuable. Speaking on the basis of non-attribution, the interviewees candidly described the circumstances surrounding their decisions, the limitations of the information available to them, and the weaknesses they perceived in the Department's policies and procedures. In keeping with the conditions under which they agreed to be interviewed, their opinions are reflected in this report without attribution.

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3 Ibid.

4 David McNicol, Brian Gladstone, Matthew Gonwa, "Cost Growth In DoD's Major Defense Acquisition Programs Since 1970 (Update)," Institute for Defense Analyses Briefing to Director ARA(OSUD(AT&L), April 2009.

5 The Nunn-McCurdy Act requires the Department to make a new determination of need and funding adequacy for programs whose projected costs rise 25% above their baseline estimates.

## II. SYSTEMS EXAMINED

Table ES-1 displays the current status of each of the eleven programs.

**Table ES-1. Acquisition Systems Examined**

<i>System</i>	<i>Date of MS- II/B Approval</i>	<i>Current Status</i>
Armed Reconnaissance Helicopter (ARH)	Jul-05	Cancelled
Expeditionary Fighting Vehicle (EFV)	Dec-00	Pre-MS-C
Future Combat System (FCS)	May-03	Pre-MS-C (Restructured)
Global Hawk	Feb-01	LRIP*
Joint Air-to-Surface Standoff Missile (JASSM)	Nov-98	LRIP
Joint Strike Fighter (JSF)	Oct-01	LRIP -4
Joint Tactical Radio System (JTRS) GMR	Jun-02	Pre-MS-C
Littoral Combat Ship (LCS)	May-04**	Pre-MS-B
Amphibious Transport Dock (LPD-17)	Jun-96	In production
Space-Based Infrared Satellite-High (SBIRS)	Oct-96	Pre-MS-C
Warfighter Information Network-Tactical (WIN-T)	Jul-03	Pre-MS-C***

\* *Low-rate initial production*

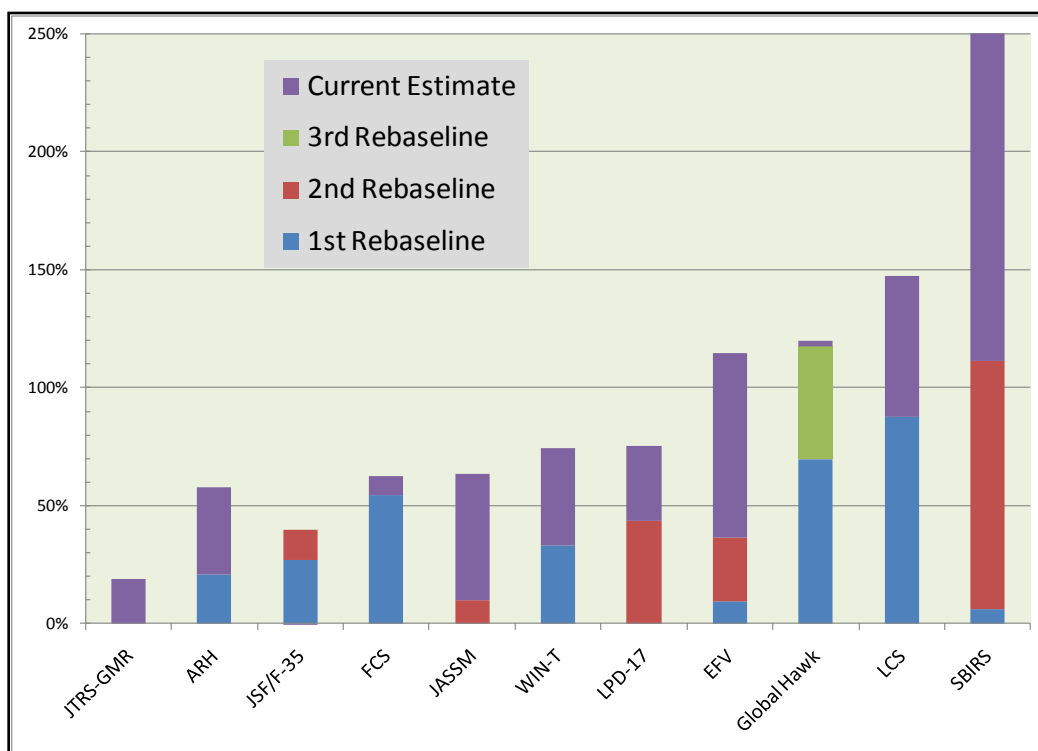
\*\* *Milestone A*

\*\*\* *Restructured. Original WIN-T program now called WIN-T Increments 2 and 3*



### III. FINDINGS

Figure ES-1 displays the programs' cost histories.<sup>6</sup> Ten of the eleven programs were “rebaselined”<sup>7</sup> one or more times after entering development: the cost increases estimated each time a program was rebaselined are shown incrementally. Where costs have been recently estimated to exceed those of the most recent baseline, the cost estimate is shown as “current.” The estimated costs of the eleven programs grew by a total of \$99 billion after they entered development—about a third of the cost growth cited by GAO for all of the 95 MDAPs active in 2007.



**Figure ES-1. Unit Cost Growth in Selected Acquisition Programs**

6 Program Acquisition Unit Cost (PAUC) was selected as the best single metric for cost growth in these programs.  $PAUC = \frac{\text{Total Program Costs}}{\text{Planned Total Units}}$

7 “Rebaselining” (replanning and repricing of future work) of a major program typically occurs incident to a formal review of program problems or changes by the DAE, including breeches of legally established thresholds.

## **A. PRIMARY CAUSES OF COST GROWTH**

The case studies appended to this report identify in detail the major causes of cost growth in each of the eleven programs. In each case, the specific elements of growth are based in two prevalent causes:

- Weaknesses in management visibility, direction, and oversight; and
- Weaknesses in initial program definition and costing.

These prevalent causes and their sub-elements are summarized below. While these observations flow primarily from our detailed review of the eleven problematic programs, they are also informed by the broad experience of the members of the IDA research team in DoD acquisition matters. There are strong reasons to believe that these findings are applicable to the general challenge of managing major acquisition programs. We hasten to note that none of these general findings are particularly new. They have all been long recognized in various forms and with varying degrees of emphasis both within DoD and by myriad outside reviews.

Avoiding cost growth is not just a narrowly technical matter of having the right organizational structure staffed by capable professionals using sound policies and procedures. Indeed, as noted elsewhere, generally sound policies and procedures have long been in place. Decisions on starting a new major defense acquisition program involve making choices on critically important matters of national security and huge expenditures of resources. Accordingly, the key decisions on MDAPs are made by politically accountable officials. Good outcomes require that those officials be given an accurate assessment of the decisions to be made and sound advice on the consequences of various alternatives. There is, however, also a legitimate policy dimension to their decisions in that the top officials of DoD decide, explicitly or implicitly, how much risk should be borne in acquisition programs and those choices have an important influence on subsequent cost growth.

### **1. General Weaknesses in Management Visibility, Direction, and Oversight**

This broad category reflects a general lack of discipline and attention to detail among the offices responsible for overseeing MDAPs in recent years. Evidence of this general lack of attention includes the decline in the documentation of independent program assessments in the Defense Acquisition Executive System (DAES). The DAES process was originally intended to provide the DAE with timely warning of problems, based in part on systematic evaluations of earned value. Other evidence of weakness includes the uneven quality of the directions provided in Acquisition Decision Memoranda (ADMs) and their associated strategy reports, as well as the lack of a system for tracking compliance with the DAE's decisions, including the tracking of

funding decisions into subsequent DoD budget requests. One result of this general lack of discipline was that problems in some programs festered for years with no formal DAE review until legal thresholds were breached.

Within the foregoing general categories of management weakness, we found the following more specific problem areas.

**a. Lax or inappropriate implementation of policies**

Over the years the Department has accumulated a great deal of experience on how to establish and manage sound major acquisition programs. These “lessons learned” track back to and also before the 1986 Packard Commission report<sup>8</sup> and are well codified in standing DoD policies and procedures. They can be summarized as “Do it right the first time.” These “standing orders” intentionally provide enough flexibility to allow each unique program to be sensibly structured and managed without imposing an inefficient “cookie cutter” straightjacket. One way to interpret the findings in this report is to observe that many of the problems it identifies can be attributed to excessive use of that flexibility. Indeed, it is common for outside critics of defense acquisition practices to say in effect “These problems wouldn’t have happened, or wouldn’t have been so serious, if the Department had only followed its own policies.”

More specifically, we identified several standing policies whose neglect contributed seriously and directly to the problems encountered by several of these MDAPs. Two of those policies proved key: (1) ensuring that the requirements for a new acquisition program are well-understood and firm; and (2) ensuring that technologies critical to successful full-scale development and production of the system are sufficiently mature. Both of those issues plagued many of the programs we examined, and will be discussed in more detail in subsequent sections of this summary.

**b. Excessive reliance on unproven management theories and acquisition strategies**

Most of these troubled programs had been subjected, in one way or another, to various “acquisition reform” initiatives that have a long and somewhat checkered history since their high point as key elements of the Clinton Administration’s “Reinventing Government” initiative. Many of those initiatives grew out of perceptions in industry and some business schools that the Department was needlessly slowing acquisition programs and driving up costs by imposing excessive specifications, compliance rules, and testing requirements. If only DoD would acquire new weapons systems more like the private sector does business, the theory went, then new

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8 David Packard, Chairman, *A Quest for Excellence: Final Report to the President*, President’s Blue Ribbon Commission on Defense Management, June 1986.

equipment would get to the warfighters faster and at lower cost to the taxpayer. Often overlooked in such exhortations was the fact that the private sector has very little experience in developing systems as large, complex, or technologically challenging as the typical MDAP. When technically complex and challenging commercial systems are developed, it is almost always “in house,” with the details concealed from public view. Such work generally constitutes the core competence of big industrial companies and is not “outsourced” under contracts to outside companies as are DoD MDAPs. The Boeing 787 “Dreamliner” is unusual in that its internal troubles have come at least partly into public view, but in fact such cost growth and delays are common in highly complex private sector programs, just as they are in MDAPs.

Our research did not extend to a systematic examination of each of the many “reforms” that have been attempted during the two decade gestation period of the programs we examined. No doubt some of the reforms – such as the shift from unique military equipment and process standards to more common industrial standards – have proven to be very worthwhile. Nevertheless, the case studies repeatedly identified elements of well-meaning but ineffective or poorly implemented reforms as major causes of cost growth. The large reductions in government expertise and oversight that accompanied these reforms (only now being partially reversed) contributed directly to delayed discovery of emerging problems and the lack of residual government expertise complicated their resolution. This more than offset any theoretical savings in reduced compliance costs, which was one goal of the reform movement. In addition, industry, when executing cost-plus contracts, does not fully share the government’s interest in cost control. Only strong government program management, not contract terms and conditions, seems to be effective in this area, and the effects of the loss of government expertise and the resulting shift of responsibility to the contractors have been starkly evident in most of the programs we examined. Virtually all of them illustrate this point, but the most serious cases include the Space-Based Infrared Satellite-(SBIRS), Littoral Combat Ship (LCS), Amphibious Transport Dock (LPD 17), the Joint Air-to-Surface Strake Missile (JASSM), and Expeditionary Fighting Vehicle (EFV).

### **c. Poor Contractor Selection**

Most new MDAPs require years of costly “invention” activities with costs that can only be roughly approximated in advance. Furthermore, the cost of development is usually only a small fraction of the total cost for programs that lead to years – or even decades – of production, such as most aircraft, ships, ground vehicles, and expendable weapons. Both of these facts argue for a de-emphasis on contractor estimates of the development costs in the initial selection, in favor of emphasizing the likely quality of the development effort and the cost and performance of the resulting system when it reaches production.

But Congressionally-driven Federal procurement laws and procedures are sharply biased toward the comparison of cost “bids” – even for cost-reimbursable development contracts. Cost “shootouts” are perfectly reasonable when the government is purchasing known commodities or fully defined end items that require little or no engineering development. But picking development contractors based primarily on their estimated development cost is highly risky. Some senior industry executives have gone so far as to suggest that government should ignore bidders’ cost estimates when making an award, and instead concentrate on the proven quality of recent work as well as the innovative ideas and expertise that the contractor would bring to the program.<sup>9</sup>

Indeed, the government has attempted to move away from cost “shoot outs” and toward “best value” contracting for complex development programs, but the increasing frequency of sustained contract award protests tends to inhibit this approach. And a black and white cost comparison is certainly much simpler and easier to understand and defend to the Congress. But it doesn’t always get the best results.

In several of the interviews we were told “off the record” that the government should have chosen a more qualified contractor for the programs we reviewed. Our research did not extend to second guessing the source selection authorities for these programs, but it is important to note that in at least one case the government was surprised by the poor or non-compliant nature of the proposals from contractors that were thought to be more highly qualified than the eventual selectee. In other cases, the lack of government expertise in the source selection process appears to have resulted in the acceptance of rosy estimates of the required work by a bidder with insufficient experience in the type of development required. SBIRS and LPD-17 fall in this category.

As noted earlier, this is not intended as a criticism of any particular source selection team. It does, however, lead directly to the conclusion that to curtail cost growth the Department must improve its ability to conduct defensible “best value” competitions for the development of those new MDAPs that do not lend themselves to fixed price contracting.

## **2. General Weakness in Initial Program Definition and Costing**

The lack of clear program definition at the point when the examined programs were approved for entry into full-scale engineering and manufacturing development was a major cause

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<sup>9</sup> *Acquisition of National Security Space Programs*, Report of the Defense Science Board/Air Force Scientific Advisory Board Joint Task Force, May 2003.

of their cost growth. It is simply not possible to reliably cost a poorly defined program, and a lack of definition usually results in cost estimates on the low side, leading inevitably to cost growth when the true complexity of the program is realized. And when the designs and their estimated costs are vague, the DoD cultural norm is to minimize the allocation of funds to any one program in order to permit more programs to be funded; which results in systemic underfunding of many—indeed most—newly approved development programs. (One role of the Cost Analysis Improvement Group (CAIG) is to strive to prevent that from occurring.)

Furthermore, processes for estimating development costs are much less mature than processes for estimating production costs. The less well-defined the intended system, the more difficult it is to estimate the material, labor, and time that will likely be needed for the completion of the “invention” phase of the program. To the extent that system preliminary designs are substantially changed during the most costly period of development, total development costs are almost certain to grow. And in several of the cases we studied, such changes did lead to substantial growth. Ultimately, schedules are placed at risk and production costs usually increase.

Several factors that contribute to this general “starting point” weakness will be explored in this section of the summary, but it should be kept in mind that there are strong interrelationships among these causes.

#### **a. Requirements Processes**

Particularly prevalent in our case studies was the incidence of unstable and defective “requirements” processes. In particular, the Department has long stated its intention to thoroughly examine a range of feasible alternatives before setting “requirements” and embarking on a major acquisition program. Among the programs we examined, it was clear that the Future Combat System, (FCS), LCS, Joint Tactical Radio System-Ground Mobile Radio (JTRS-GMR), Warfighter Information Network-Tactical (WIN-T), and Armed Reconnaissance Helicopter (ARH) had not had a serious analysis of realistic alternatives. In the case of LCS and FCS this was the result, in large part, of early decisions on preferred approaches made by top Service leadership—decisions that had a chilling effect on the enthusiasm of subordinate personnel advancing alternatives. After we completed our research, the GAO, in an examination of a larger number of MDAPs, reported a strong correlation between the neglect of robust Analyses of Alternatives and subsequent cost growth.<sup>10</sup>

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<sup>10</sup> Report to the Chairman, Subcommittee on National Security and Foreign Affairs, *Many Analyses of*

The requirements for the vast majority of MDAPs are developed by the military Services and reviewed by the Joint Requirements Oversight Council (JROC) under the auspices of the Joint Staff. The complex and lengthy Joint Capabilities Information and Development System (JCIDS) process was implemented to inform the process of JROC review; however, we found no instance in which the JCIDS process significantly altered any solution originally proposed by a military service, nor did it appear that the process has added value to the front end of the acquisition process for the programs examined.

Several programs we examined underwent major changes in requirements after they were well into full-scale development without a full consideration of the likely effects of the changes on schedule and cost and without rebaselining. Full estimation of the additional cost might have reversed the conclusion that the programs were cost effective, and led the DAE to reverse his decisions that they go forward. Such re-examination appears to have occurred only when forced by the legal requirements of the Nunn-McCurdy Act and then only cursorily. Global Hawk is the most salient example among the programs we examined.

As noted above, in some cases, another issue related to requirements definition has been “command influence.” That is, when a service chief defined both the key characteristics of a desired new weapon system in considerable detail and tried to mandate its schedule and even its cost, our interviews of stakeholders indicated a general reluctance on the part of subordinates to try to “expand the envelop” to systematically examine other potential configurations or more realistic schedules and costs. FCS and LCS, and to a lesser extent, ARH, are prime examples of this situation.

#### **b. Immature Technologies**

Another well-settled basic principle of sound acquisition planning is to ensure that all technologies critical to the eventual performance of the intended system have reached an adequate level of maturity before the full project is approved for entry into full-scale engineering and manufacturing development. However, few of the programs we examined came close to meeting that standard. In FCS, SBIRS, JTRS-GMR, and WIN-T only a small fraction of the key technologies were sufficiently mature, but the programs were nonetheless approved to proceed into development, possibly in some cases to avoid the appearance that the Department was losing momentum on initiatives that had high level support. Even if individual technologies are assessed as ready to support full-scale development, integration is critical at the system of

systems level, and currently there is no assessment made of the readiness of technologies to achieve that integration. This issue is closely related to shortfalls in front-end systems engineering, discussed below.

### **c. Systems Engineering Shortfalls**

A common theme in our case studies was the notable lack of systems engineering discipline before these complex programs entered full-scale development. Without the comprehensive allocation of work effort that results from sound systems engineering, realistic scheduling and material and labor cost estimating was essentially impossible.

The deficiencies in early systems engineering was consistent with the general effort to sharply limit spending in the early years of program development. Systems engineers are expensive and scarce and, under historical policies and practices, not considered highly essential in the early phases of program definition. These shortfalls in early systems engineering shortchanged MDAPs both at the program-office/commodity-command and at the OSD review levels, where there has been a dearth of experienced systems designers capable of providing and supporting the type of independent cost review provided by the CAIG.

The consequences of these early systems engineering deficiencies included serious underestimation of the scope of the required development effort, a failure to identify key risk areas that warrant extra effort, and requirements-design mismatches. These factors individually and collectively led to high cost growth relative to initial estimates, at least for development and probably for the production as well.

### **d. Schedule Compression and Concurrency**

Most of the programs experienced some form of schedule compression and/or concurrency during some phases of the program. The lack of robust early systems engineering contributed to generally unrealistic hopes that the development schedule could be more compressed than it was for previous successful developments. The resulting excessive concurrency without adequate risk mitigation funding and developmental testing invariably led to the need for rework and retesting, usually resulting in longer, rather than shorter, delivery times and associated cost growth.

## **3. Overlap of General Weaknesses**

Elements of the foregoing major weaknesses overlap considerably. For example, when a program receives approval to enter development despite being so ill-defined and technically immature that its costs cannot be estimated with even rough confidence, it presents prima facie

evidence not only of weaknesses in management oversight, including lax implementation of policies, but also in program definition and costing.

Table ES-2 displays the incidence of the factors described above among the eleven programs. Our review indicated that cost growth in each program presents a somewhat unique syndrome generated by several contributing factors, as shown in Table ES-2. When taken together, certain factors tend to dominate the results.

We did not attempt to establish a set of controls based on programs other than the eleven we examined. Consequently, we do not know the extent to which:

- The factors in Table ES-2 were largely absent for MDAPs with modest cost growth; or
- The factors were present but they merely operated with less intensity.

We do know, however, that the factors in Table ES-2 were the major contributors to cost growth in the high cost growth programs we examined. Hence, the recommendations presented in a subsequent section of this report respond primarily to the causes in the programs we looked at, while recognizing that further research would be needed to clarify the broader picture. Nonetheless, even if those causes were found to apply exclusively to the eleven programs (an unlikely premise), they deserve serious attention because of the *importance of those particular programs*.

**Table ES-2. Areas of Weakness Causing Cost Growth in Programs Investigated**

	1. Top Management Activities			2. Initial Program Definition and Costing			
	a.	b.	c.	a.	b.	c.	d.
	<i>Implementation of Policies</i>	<i>Implementation of Acquisition Reforms</i>	<i>Contractor Selection, Oversight, and Incentivisation</i>	<i>Requirements Processes</i>	<i>Immature Technologies</i>	<i>Systems Engineering</i>	<i>Schedule Compression and Concurrency</i>
ARH			X	X	X	X	X
EFV		X	X	X		X	X
FCS	X		X	X	X	X	
Global Hawk	X	X	X	X		X	X
JASSM		X	X	X		X	X
JSF				X		X	X
JTRS	X			X	X	X	
LCS		X	X	X		X	X
LPD-17		X	X		X	X	X
SBIRS	X	X	X	X	X	X	X
WIN-T	X				X	X	

## **B. CONCLUDING REMARK**

While each program described above demonstrates a unique cost-growth syndrome, together they validate a unifying insight: in each of them cost growth could have been greatly reduced or eliminated if policies and procedures previously developed and promulgated for that purpose had been more rigorously followed. More rigorous compliance with standing policies would, in most cases, have delayed the system's entry into (but not necessarily its completion of) development. In several cases it would have forced a system with expanded requirements to re-qualify for development. And it would have raised the standard of initial systems definition and systems engineering to levels that made cost estimation practicable and successful development more likely. The recommendations presented below are intended to re-instill the necessary rigor in the Department's acquisition process.

## **IV. RECOMMENDATIONS**

The following recommendations are intended to help prevent, or least alleviate, each of the major causes of cost growth identified in our study. They are directly supportive of the goals established by the Weapon Systems Acquisition Reform Act of 2009 (WSARA).<sup>11</sup> These detailed recommendations flow from, but are not tightly tied to, specific causes identified in each of the case studies.

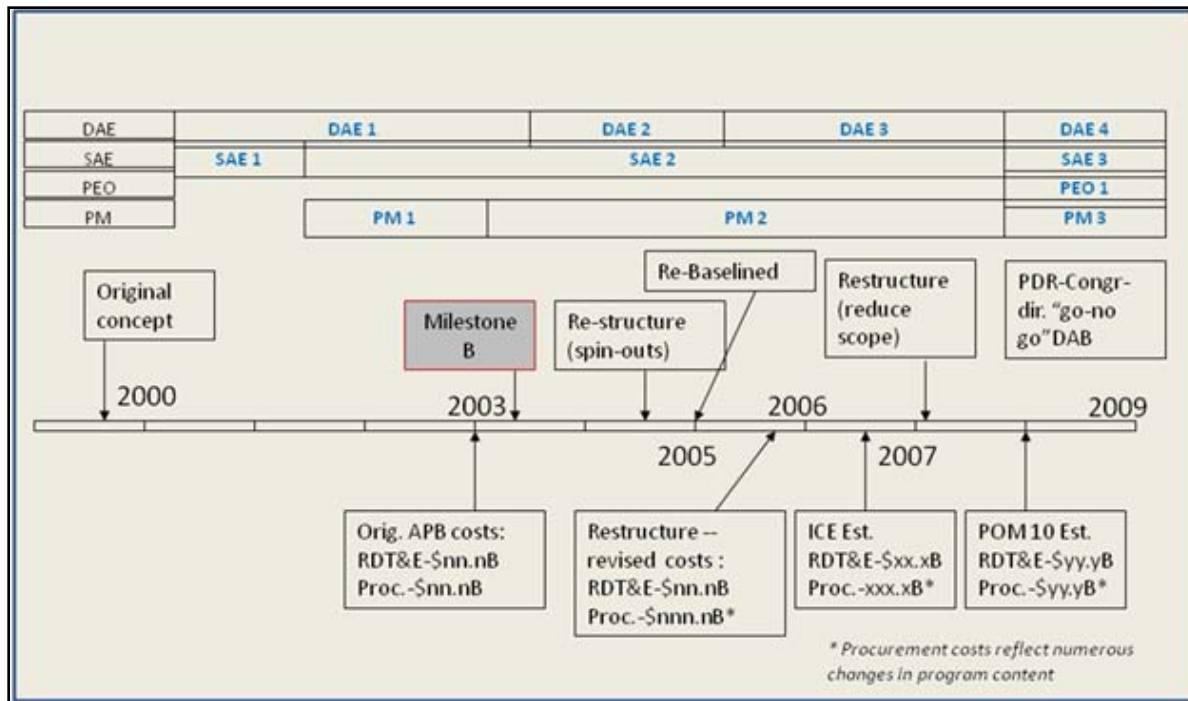
Several of our recommendations entail increasing the government's expertise in systems engineering and management – a process requiring more senior, experienced people. This appears quite feasible under the recently increased authorized size of the defense acquisition corps, but it will take years to complete. In the meantime, experienced people who are free of conflicts of interest can likely be “borrowed” for specific reviews from government laboratories, University Affiliated Research Centers, and Federally Funded Research and Development Centers, all of which are within the purview of the DAE.

### **A. IMPROVE DEFENSE ACQUISITION EXECUTIVE MANAGEMENT OVERSIGHT**

The DAE should establish a greater sense of commitment and accountability among the leaders of the acquisition team through a formal process for tracking commitments made at Defense Acquisition Boards (DABs) and at other OSD reviews. This process should include tracking the implementation of ADM directives in both contracts and budget documents. Tracking should become a regular feature of a revitalized DAES review process that is designed to identify MDAP problems early enough for the DAE to take appropriate corrective action. A useful top level outline of a tracking process is shown in Figure ES-2 below.

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11 Weapon Systems Acquisition Reform Act of 2009, Public Law 111-23-May 22, 2009, 111th Congress.



**Figure ES-2. Template Used to Track Record of Progress for MDAPs**

## **B. STRENGTHEN THE ANALYTIC BASIS FOR SETTING MAJOR DEFENSE ACQUISITION PROGRAMS REQUIREMENTS**

The DAE should work closely with the Director CAPE to reinvigorate mission-area type analyses of the capabilities needed to meet the Secretary's defense strategy to identify both appropriate changes in ongoing MDAPs, and the key performance requirements of any new materiel needs. These analyses should include an appropriate range of materiel and non-materiel alternatives, including programs recommended by the DoD Components and by the Joint Staff. Essential to such analysis is sufficient technical expertise to permit accurate assessment of the feasibility, risks, and likely cost of any candidates proposed for new materiel solutions.

## **C. RENAME AND RESTART PROGRAMS WITH MAJOR SCOPE CHANGES**

Whenever a major change is being considered for an MDAP, the DAE should conduct a DAB review that includes potentially renaming and formally restarting the program at an appropriate milestone with a new Acquisition Program Baseline and Selected Acquisition Report.

## **D. STRENGTHEN TECHNICAL OVERSIGHT**

The DAE should establish a CAIG-like Systems Engineering Improvement Group (SEIG) to conduct independent reviews of the proposed design concept and development plan of new MDAPs. The group should comprise experienced systems designers, and the reviews should

be scheduled early enough to help the CAIG by strengthening preparation of the Cost Analysis Requirements Description (CARD). One of its goals should be ensuring that the development funding plan is adequate to limit the risks at the next milestone to acceptable levels.

#### **E. IMPROVE CONTRACTOR SELECTION**

The DAE should strengthen the government's ability to assess the realism of contractor proposals for MDAP development and to make awards based on "best value." To this end, source selection for cost-type development contracts should de-emphasize the contractor's estimates of the likely cost in favor of an increased emphasis on the contractor's technical approach and overall qualifications and the government's estimate of the likely cost for that contractor to successfully complete development in a way that leads to affordable production costs. In addition the DAE should strengthen the qualifications of the government's pre-award survey teams.

Another step would be to strengthen the process for ensuring that only clearly qualified contractors are solicited for formal bids by increasing the use of the past performance database.

#### **F. STRENGTHEN AFFORDABILITY ASSESSMENTS**

To limit "over-programming" of MDAPs beyond the Future Years Defense Program (FYDP) years and the resulting "bow wave" of unaffordable programs, the DAE should work with the Director CAPE to ensure that the Defense Program Projection (DPP) is updated at least annually. Then it should be used explicitly at each DAB to assess long-term affordability within the expected acquisition portfolio funding totals. The annual Program Objective Memorandum (POM) review should include an assessment of the longer-term affordability of the entire acquisition program, as well as a verification of the implementation of the DAB-approved funding plans for each MDAP.

#### **G. AVOID UNPRODUCTIVE PROTOTYPING**

Acquisition executives should ensure that full funding is provided for competitively prototyping of those elements of a new system for which such prototyping can be shown to be cost effective. Do not rely on prototyping as a substitute for robust systems engineering.

#### **H. AVOID INEFFECTIVE OR MISGUIDED REFORMS**

When considering potential new "reforms" of the DoD acquisition management system, the DAE should first subject proposals to controlled trials on one or a few appropriate programs. Only when the data from such "pilot programs" have demonstrated the effectiveness of the intended improvement should consideration be given to the wider application of the reform. The

results of prior reform efforts should be thoroughly assessed before failed approaches are reconsidered.

#### **A FINAL NOTE**

Implementation of these recommendations will require no changes to existing legislation, and, with the possible exception of the creation of the SEIG, no major organizational changes within the Pentagon. Implementation will, however, require a considerable increase in the diligence with which the DAE, his staff, and other members of the defense acquisition team implement longstanding policies (as reflected in extant DoD directives) and best acquisition practices. Those practices are rooted in the report of the 1986 Packard Commission, have been expanded by numerous subsequent studies, and are further reinforced by the Weapon Systems Acquisition Reform Act of 2009.

## V. SUMMARY OF REVIEWS OF SELECTED PROGRAMS

This section provides snapshots summarizing the cost growth and its major causes for each of the eleven programs selected for in-depth examination by the IDA study team. Additional details may be found in Volume III which contains the appendices to the main report. The Appendixes are For Official Use Only.

### A. ARMED RECONNAISSANCE HELICOPTER

The Armed Reconnaissance Helicopter is an OH-58D Kiowa Warrior replacement based on commercial components.

**Table ES-3. ARH Schedule and Cost Growth**

MS I/A: None	MS B: Oct 96	Cancelled: Oct-08	
	ORIGINAL BASELINE	EST. AT CANCELLATION	GROWTH
EMD duration (yrs.)	3.9	6	+2.1 (55%)
Aircraft	368	512	+144 (40%)
PAUC (FY05\$M)	8.56	14.15	+5.59 (65%)
Total (FY05\$B)	3,171	7,246	+4,075 (130%)

- The requirement that two ARHs fit into a C-130 and be ready to fly within 15 minutes after the C-130 landed eliminated several potential vendors
- An unrealistic initial requirement that Low-Rate Initial Production (LRIP) unit cost be no greater than \$5.2 million further reduced competition
- The initial decision to base the ARH on a commercial helicopter then in development led to a spiral of cost growth when the commercial helicopter failed to go into production
- Lack of adequate early systems engineering encouraged unrealistic scheduling
- The Army directed major changes to the configuration and mission equipment that was originally bid (and not all associated technologies were mature)
- Testing and data requirements to achieve Army air worthiness certification were at issue



## B. EXPEDITIONARY FIGHTING VEHICLE

The Expeditionary Fighting Vehicle is an amphibious 17-man infantry fighting vehicle to replace the AAV7.

**Table ES-4. EFV Schedule and Cost Growth**

MS I: Mar 1996	MS B: Dec 2000	EMD re-started: Jun 2008	
	ORIGINAL BASELINE	LATEST ESTIMATE	GROWTH
MS B to IOC (yrs.)	5.8	14.7	+8.9 (155%)
Vehicles	1,025	592	-433 (-40%)
PAUC (FY97\$M)	8.21	22.20	+13.99 (170%)
Total (FY97\$B)	8.44	13.16	+4.72 (55%)

- Basic system design challenges, particularly the impact of a power/weight ratio more akin to aircraft than to landing craft, went unrecognized for years, reflecting inadequate early systems engineering
- A compressed schedule with funding limitations led to a prototype design based on inadequate test data, leading to multiple slips for additional testing
- Reliability failures forced a repeat of the development phase and building of new prototypes
- Hands-off “reformed” management let problems fester and grow (Government program management office inadequately staffed)

## C. FUTURE COMBAT SYSTEM

The Future Combat System<sup>12</sup> is the Army’s “transformational” program to combine unmanned and manned systems, sensors, and an advanced broadband communications network for the next-generation combat brigade.

**Table ES-5. FCS Schedule and Cost Growth**

MS I/A: None	MS B: May 2003		
	ORIGINAL BASELINE	LATEST ESTIMATE	GROWTH
EMD duration (yrs.)	7.6	14.3	+6.7 (90%)
Brigade sets	15	15	–
PAUC (FY03\$B)	5.18	8.40	+3.22 (+60%)
Total (FY03\$B)	77.14	125.36	+48.22 (+60%)

- Since FCS comprised 14 different component sub-programs, procurement quantities are not meaningful
- At Milestone B, the program was largely conceptual; only three of its 44 critical technologies were mature
- The lack of system definition precluded realistic initial costing and sound systems engineering
- The conceptual premise that battlefield superiority for Army brigades could be achieved through exploitation of broadband communications capabilities proved to be far more technically challenging than anticipated
- The “program” was in fact a collection of a number of advanced systems and technologies, and attempts to manage those as a coherent single development under a Lead System Integrator contract met with only limited success

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<sup>12</sup> Prior to program restructuring by the Obama Administration.

## D. GLOBAL HAWK

Global Hawk is a long-endurance high-altitude unmanned air system for intelligence, surveillance and reconnaissance.

**Table ES-6. Global Hawk Schedule and Cost Growth**

MS I/A: None	MS B: Feb 2001		
	ORIGINAL BASELINE	LATEST ESTIMATE	GROWTH
EMD duration (yrs.)	5.7	8.8	+3.2 (56%)
Air Vehicles	63	54	-14%
PAUC (FY00\$M)	69.0	150	+81 (117%)
Total (FY00\$B)	4.3	8.01	+3.71 (186%)

- Shortly after Milestone B/II approval, the Air Force, working with the Office of the Under Secretary of Defense, Intelligence, conducted a sensor requirements review that resulted in a decision to increase the capacity of the air vehicle by 50% to accommodate multi-sensor payloads
- Both the contractor and the Air Force program office grossly underestimated the difficulty and the additional cost to develop and produce the larger aircraft
- Weak systems engineering, lack of effective prototyping, and a compressed, concurrent schedule resulted in much rework
- Program office resources were stressed by the need to support operational deployments of early production systems

## E. JOINT AIR-TO-SURFACE STANDOFF MISSILE

The Joint Air-to-Surface Standoff Missile (JASSM) is a stealthy tactical missile with a 1000-lb warhead.

**Table ES-7. JASSM Schedule and Cost Growth**

	MS I: Jun 1996	MS II: Nov 1998	
	ORIGINAL BASELINE	LATEST ESTIMATE	GROWTH
MS II to IOC (yrs)	5.1	6.1	+1.0 (20%)
Missiles	2,461	5,006	+2,545 (105%)
PAUC (FY95\$k)	709	1167	+451 (64%)
Total (FY95\$B)	1.73	5.21	+3.48 (201%)

- Applying a number of acquisition reforms, the program set out to develop and produce a missile in about half the time and at half the cost of similar programs
- The contractor “bought into” the government’s cost objective by providing a low-cost, largely fixed-price bid for development and initial production lots
- The sole-source contractor was given exceptionally broad authorities to execute the program, including the power to make cost-performance tradeoffs
- Problems with poor manufacturing quality and supplier management resulted in a missile that did not demonstrate reliability acceptable to operators (even though technically compliant with the contract)
- Result: the government was unable to execute lot production contracts at rates sufficient to achieve price objectives
- Subsequently, an additional requirement for an extended range missile, doubling the originally planned quantities, was added without approval by the JROC or DAE, further increasing average unit cost

## F. JOINT STRIKE FIGHTER

The Joint Strike Fighter (F-35) (JSF) is a multinational stealthy strike fighter to replace F-16s, early F/A-18s, and Harriers.

**Table ES-8. JSF Schedule and Cost Growth**

	ORIGINAL BASELINE	LATEST ESTIMATE	GROWTH
MS I: Sep 1995			
MS B: Oct 2001			
MS B to IOC (yrs.)	8.5	10.4	+1.9 (25%)
Aircraft	2,866	2,458	-408 (-15%)
PAUC (FY02\$M)	61.9	88.0	+26.0 (40%)
Total (FY02\$B)	175.6	216.0	+40.4 (+25%)

- Inadequate systems engineering led to underestimation of the complexity inherent in the plan to combine conventional and carrier-based aircraft with a short take-off and landing (STOVL) variant
- Pre MS B flying prototypes costing more than \$1B contributed very little to the knowledge base but reduced resources for early systems engineering
- Increased complexity to reduce weight increased material cost
- The development schedule was excessively concurrent
- Unresolved risks and the concurrent schedule led to a crisis, particularly in weight growth, forcing a redesign that increased system complexity and cost

## G. JOINT TACTICAL RADIO SYSTEM-GROUND MOBILE RADIO

The Joint Tactical Radio System-Ground Mobile Radio is a software-defined radio for ground forces at the tactical level that supports the FCS.

**Table ES-9. JTRS-GMR Schedule and Cost Growth**

MS I/A: N/A	MS B: Jun 2002		
	ORIGINAL BASELINE	LATEST ESTIMATE	GROWTH
MS B to IOC (yrs)	4.6	9.5	+4.9 (110%)
Radios	108,388	86,632	-21,736(-20%)
PAUC (FY02\$k)	133	164	+31 (25%)
Total (FY02\$B)	15.3	16.0	+0.7 (5%)

- The program entered development with none of its 20 critical technologies at the required readiness level, leading to a schedule delay of five years and significant cost growth
- Providing broadband internet protocol (IP) services to forces on the move, required to support FCS, was far more challenging than anticipated
- Expected use of commercial-off-the-shelf (COTS) developments and products to meet such needs proved to be highly unrealistic
- Increased information assurance requirements further delayed schedules and increased design complexity and costs

## H. LITTORAL COMBAT SHIP

The Littoral Combat Ship is a fast 3,000 ton multipurpose warship with modular payloads.

**Table ES-10. LCS Schedule and Cost Growth**

MS A: May 2004	MS B: Not yet		
	ORIGINAL BASELINE	LATEST ESTIMATE	GROWTH
Phase I span (yrs.)	2.7	6.1	+3.4 (130%)
Ships	4	2	-2 (-50%)
Unit cost (FY00\$M)	293	1,474	+1,181 (405%)
R&D Total (FY00\$M)	1,173	2,948	+1,775 (150%)

- Lack of early program definition and extraordinarily concurrent scheduling led to chaotic development
- Late imposition of a requirement for construction to comply with newly-issued Naval Vessel Rules forced extensive redesign while construction of the first ship was in progress
- The initial cost target directed by the Chief of Naval Operations (CNO) and reported to Congress was not based on analysis
- The government placed heavy reliance on acquisition reforms, cutting back oversight and support

## I. AMPHIBIOUS TRANSPORT DOCK (LPD 17)

The Amphibious Transport Dock is a medium amphibious transport ship, replacing several older models.

**Table ES-11. LPD-17 Schedule and Cost Growth**

	ORIGINAL BASELINE	LATEST ESTIMATE	GROWTH
MS I: Jan 1993			
MS II: Jun 1996			
MS II to IOC(yrs)	7.6	11.8	+4.3 (55%)
Ships	12	10	-2 (-15%)
PAUC (FY96\$M)	752	1,356	+602 (80%)
Total (FY96\$B)	9.02	13.56	+4.54 (50%)

- Budget-driven cost estimate
- Complexity of ship underestimated in initial cost estimates
- Minimally qualified contractor was given broad responsibility and control with little oversight or support from government
- Major savings assumed from unproven innovations and technologies that did not materialize
- Construction pressed ahead even though designs were incomplete, resulting in rework
- Disruption resulting from hurricane Katrina

## J. SPACE-BASED INFRARED SYSTEM (HIGH)

The Space-Based Infrared System is a global infrared surveillance and ballistic missile warning satellite, replacing the Defense Support Program (DSP).

**Table ES-12. SBIRS Schedule and Cost Growth**

MS I/A: N/A	MS II: Oct 1996		
	ORIGINAL BASELINE	LATEST ESTIMATE	GROWTH
MS II to IOC (yrs.)	7.2	14.8	+7.7 (110%)
GEO satellites	5	4	-1 (-20%)
PAUC (FY95\$M)	694	2,354	+1,660 (240%)
Total (FY95\$B)	3.33	9.36	+6.03 (180%)

- Initial cost estimates, based on expected use of commercial technologies and unproven acquisition reform initiatives, were well below precedent
- The government encouraged and accepted low bids based on unrealistic assumptions
- Very weak early systems engineering led to weak risk recognition and control
- The government largely ceded program management responsibility to a contractor that could not meet it and the government program office staff was reduced accordingly
- Consistent underfunding resulted in attempts at shortcuts that did not materialize

## K. WARFIGHTER INFORMATION NETWORK-TACTICAL

The Warfighter Information Network—Tactical is a high-capacity backbone communications network for Army tactical forces, theater-level and below that supports the FCS.

**Table ES-13. WIN-T Schedule and Cost Growth**

MS I/A: N/A	MS B: Jul 2003		
	ORIGINAL BASELINE	LATEST ESTIMATE	GROWTH
EMD duration (yrs)	2.3	7.8	+5.4 (+230%)
Total (FY03\$B)	9.9	17.2	+7.3 (75%)

- Immature technologies, poorly defined requirements, and immature systems design resulted in unrealistic initial cost and schedule estimates
- Commercial communications technologies proved unable to meet the needs of maneuvering tactical forces
- Unit cost increases reflect immature initial system definition—one radio increased from an estimated \$130K to about \$900K
- The Army merged the efforts of two competing contractors to achieve a common architecture based on “best of breed,” resulting in schedule delay and cost growth
- Changing requirements due to major changes in Army force structure and in FCS requirements

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